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It is therefore a matter of congratulation to all who are interested in this inviting field to learn that Messrs. Cash and Hopkinson have undertaken the preparation of a monograph of the Rhizopoda and Heliozoa of the British Isles. Penard's exhaustive treatises upon these organisms of the Swiss lakes have provided continental Europe with a very complete account of these protozoans and the present work aims at a similar analysis of the British fauna. The first volume includes the order Amoebina and a small part only of the Conchulina, proposed by the author in place of the Testacea of M. Schultze. In all, 17 genera and 46 species are described. The work is illustrated with well-executed lithographic plates and numerous text-figures, and is provided with very complete bibliographic and synonymic references, supplementing in these respects the more detailed and extensive works of Penard. The fullness of the bibliographic lists is shown by the fact that the references under *Amoeba proteus* occupy five closely set pages.

The introductory chapter discusses briefly the structure and activities of the rhizopodan cell and the structure and method of formation of the test. The discussion of the distribution and known habitats of the various genera and of the best methods of collecting rhizopods is both instructive and helpful. We note the revival of Leidy's genus Ouramoeba founded on individuals bearing a peculiar filamentous appendage. Professor W. L. Poteat has shown[1] that these supposed appendages are merely the mycelial hyphae of some parasitic fungus, a view which Penard also subsequently adopted. The authors seem not to have been aware of Poteat's work.

C. A. Kofoid.

BOTANY

Recent Studies on Gymnosperms.— Among the numerous recent contributions to our knowledge of the gymnosperms several are of more than usual importance. These deal with all the four orders and include work both on living and on fossil forms.

The discovery of spermatozoids in the cycads in 1896, and of those of Gingko at about the same time by the Japanese botanists Ikeno and Hirase, and shortly after Webber's studies on Zamia, gave a great impetus to the investigations on these very important plants, and our knowledge of these forms has been very materially increased during the past decade.

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[1] Poteat, W. L. Leidy's Genus Ouramoeba. *Science*, N. S. vol. 8, p. 778–782.

Among the most important of the more recent papers are those of Chamberlain (The Ovule and Female Gametophyte of Dioon. C. J. Chamberlain. *Bot. Gaz.*, XLII, Nov. 1906, pp. 322–358. Pls. XIII–XV. Preliminary Note on Ceratozamia. Ibid., XLIII, Feb. 1907, p. 137) and that of Caldwell on *Microcycas calocoma* (Microcycas Calocoma. O. W. Caldwell. *Bot. Gaz.*, XLIV, Aug. 1907, pp. 118–141).

The three genera treated in these papers are all peculiar to America. Dioon and Ceratozamia being Mexican, while Microcycas is confined to a limited district in the western part of Cuba.

Professor Chamberlain made careful studies in the field, where he collected a good deal of material, but his studies also included living material sent to Chicago from the region where Dioon grows. The latter is abundant in a region about twenty-five kilometers from Xalapa, the capital of the state of Santa Cruz. Apparently Dioon is confined to this very limited area. The plant much resembles Cycas, but does not attain the dimensions of *C. revoluta* or *C. circinalis* as these occur in their native habitats. The largest specimen seen had a height of only three meters; but nevertheless it was estimated that these plants were at least one thousand years old. The growth is excessively slow, and a careful study of the rate of growth of plants in cultivation has led to this extraordinary estimate of the age of the larger plants.

The plants are said to fruit freely every other year. The ovulate cones are very large, sometimes weighing six kilograms or more, and the large size of the sporophyll approximates that of Cycas, although the sporophylls are arranged in a definite cone. The lower leaves of the cone are sterile and there are intermediate forms between these sterile leaves and those that bear the ovules. Each perfect sporophyll bears two very large ovules, which may reach a length of four centimeters. The ovules do not ordinarily attain their full development unless pollination takes place.

Full details are given of the methods used in studying the development of the ovule and there is also a complete account of its morphology. The question of the possible double nature of the integument is left unsettled.

At the time of pollination there is a considerable amount of tissue at the apex of the nucellus, above the embryo sac; but later this is destroyed, partly by the growth of the pollen tubes and embryo sac, and unquestionably the pollen tubes come into direct contact with the archegonia. A pollen chamber is present as in the other cycads, immediately after pollination. A very conspicuous jacket surrounds the endosperm, and the megaspore membrane is easily identified. The walls of these jacket cells are strongly suberized. The jacket cells seem to be concerned with the nutrition of the endosperm.

Unfortunately the younger stages of the gametophyte could not be secured. The earliest ones collected in November already had the initials of the archegonia developed. The development of the latter is probably not essentially different from that of Cycas. The prothallium is fully developed in April and at this time the archegonial chamber is complete. The megaspore membrane becomes thick and shows the clear differentiation into an endospore and exospore as in the heterosporous pteridophytes.

The archegonia are enormously large and there may be as many as ten present. As in the other cycads that have been investigated, there are two neck cells. A ventral canal cell nucleus is separated from the very large egg nucleus. The number of chromosomes was estimated to be twelve. The egg may reach a length of six millimeters, and the nucleus is correspondingly large, in some cases being as much as 600μ. in diameter. In spite of this enormous size, the nature of its minute structure was not satisfactorily made out.

The paper is accompanied by several excellent photographs and by three plates.

Chamberlain's second paper is a preliminary note on the Mexican genus Ceratozamia. This differs much in its habitat from Dioon, being a shade-loving form, while Dioon is markedly xerophytic. Fertilization was found to occur more than a year subsequent to pollination. Motile spermatozoids resembling those of Cycas and Zamia were seen. The seed has no resting period, but growth is continuous from the time of fertilization to the emergence of the young sporophyte from the seed.

Professor Caldwell's paper on *Microcycas calocoma* is a very interesting account of a little known cycad from the sierra of western Cuba.

In habit, the plant recalls *Cycas revoluta*, and like that species shows various forms of branching. The largest specimens attained a height of more than nine meters.

The ovulate cones are the largest yet known. One of these measured ninety-four centimeters in length and weighed nine and five tenths kilograms. The staminate cone is much smaller.

The most important discovery made was the remarkable character of the male gametophyte, which is the most primitive yet discovered among the seed bearing plants. The fully developed pollen tube contains a prothallial cell, a tube nucleus, stalk nucleus and eight body cells, each of which develops two large sperm cells, thus giving rise to sixteen large spermatozoids similar to those known in several other genera of cycads. In exceptional cases as many as ten body cells were noted. Whether, as seems probable, the eight body cells are formed from the division of a primary one was not determined. The male gametophyte of Microcycas is thus seen to be less reduced than that of some heterosporous pteridophytes, *e. g.* Isoetes, Salvinia, Azolla, while no other living seed plant is known to show more than two generative cells, unless possibly Araucaria, where a large number of nuclei have been reported in the pollen tube, the exact nature of which, however, is somewhat problematical.

The development of the female gametophyte was not followed in detail, but it was found that the number of archegonia is very large, sometimes exceeding two hundred. So far as could be determined, the archegonium is of the same type as that of the other cycads.

The ripe seed contains a single large, straight embryo, with three to six cotyledons. The young plant produces a tuberous stem several centimeters in length before the first true leaf emerges. The author concludes that Microcycas is the most primitive of all the known cycads. The paper is illustrated by a number of excellent photographs and there are three plates showing the most important points in the development of the gametophyte.

The remarkable series of fossil cycads from different regions in the United States, but especially from the Black Hills of Wyoming and South Dakota has been exhaustively treated in the magnificent memoir by Wieland (American Fossil Cycads. G. R. Wieland. Carnegie Institution of Washington, No. 34, 1906). Space will not permit a complete review of this volume, which comprises nearly three hundred quarto pages, with fifty plates and many text figures. The work is mainly based upon the great collections in the museum of Yale University, the most important collection of fossil cycads in existence.

The introductory chapter deals with the discoveries and collections of fossil cycads in Europe and America. The second chapter treats of the preservation of the fossil forms and discusses at length the external characters of living cycads. A number of admirable figures are given, including some of the curious culture forms of *Cycas revoluta*, which is a favorite with Japanese gardeners. Some of these garden forms are curiously like many of the fossil cycad trunks. An interesting account is given of the methods used in cutting sections of the petrified trunks. Tubular drills were employed to cut out solid cores for studying fruits, etc. These cores were then sectioned in the desired directions. In this way the trunks could be fairly well preserved.

Chapter four is concerned with the structure of the trunk, both the external layer, which is mainly composed of large, closely packed scales, "ramentum," and the internal structure, which is often preserved in a very perfect way and makes the structure of the trunks perfectly clear. For details the reader must be referred to the memoir.

The leaves of the fossil cycads have been preserved in many instances in a remarkably perfect manner, even the young unfolded leaves being clearly evident in some specimens. This is particularly the case in one species, *Cycadeoidea ingens.* The young leaves were apparently quite similar to those of Dioon or Macrozamia. As is the case with the stem, the internal structure of the leaves is also perfectly preserved.

It is the reproductive parts of these fossil cycads, however, that are of the greatest interest. While some of these are of the same type as those of the living cycads, one group, sometimes separated from the true cycads as a special order, Bennittitiales, had bisporangiate cones, which apparently were curiously like the flowers of certain angiosperms. Some of these have been preserved in a wonderfully perfect manner owing to the young cones being completely protected by the armor of scales in which they were imbedded. The "flower" consists of a central conical receptacle which bears slender sporophylls, each one terminating in a single ovule. Surrounding this ovulate receptacle was a series of pinnate microsporophylls, each one bearing a large number of "synangia," extraordinarily like those of the fern Marrattia. Surrounding the whole strobilus was a series of elongated scales or bracts very much like the floral envelopes of certain angiosperms.

The type of cone shown in these Bennettiteae is much more specialized than that of the living cycads, but it is questionable whether the resemblance to the angiospermous flower is anything more than a coincidence. Nevertheless in the search for the ancestors of the prevailing type of seed plants, one is tempted to assume an actual relationship between these and the Cycadeoideae.

The preservation of the seeds is also very perfect, and in some cases dicotyledonous embryos can be recognized within the petrified seeds. Some of the specimens of the young ovules were very perfectly preserved and these showed what seemed to be prothallial structures suggesting those of Gingko. More evidence, however, is necessary before it can be certainly decided what was the process of the development of the prothallium and embryo. The species in which the bisporangiate cone is best shown has been named *Cycadeoidea dakotensis*.

In chapter nine there is given an excellent comparison of the existing and fossil cycads. There are but one hundred and seven described species of living cycads, included in nine genera, of which four belong to the New World and five to the Old World (including Australia). As we have seen in the consideration of Chamberlain's and Caldwell's papers, three of the four American genera are of very limited distribution, Zamia being the only American genus of fairly extended range. Three of the Old World genera, *i. e.* Cycas, Encephalartos and Macrozamia, are much more widespread. As is well known, the cycads were a predominate plant type during most of the Mesozoic, when this type reached its culmination.

The affinities of the cycads with ferns have been long recognized and Wieland's work strongly confirms the view that these have arisen from ferns of marattiaceous affinity. The extraordinarily Marattia-like microsporangial sori of Cycadeoidea are especially striking in this connection. Wieland discusses the question whether the Cycadeoideae, that is, those forms with bisporangiate cones, should be separated as a special order, Bennettitiales, as recognized, among other authorities, by Engler and Prantl. This view is not accepted by all botanists however, some of whom, like Scott, recognize three families, Cycadeae, Zamieae and Bennittiteae, all referable to a single order, Cycadales. This latter view is supported by Wieland, who believes that from the great complex of Cycadofilices or Pteridosperms (seed-bearing ferns) a group which is now known to have been highly developed during the Paleozoic, there arose the common ancestors of the true cycads and Bennittiteae, the group becoming more and more divergent as they developed through the Mesozoic. Of these two divisions, only the true cycads have survived to the present time.

The final chapter is taken up with a discussion of the relation of the cycads to the ferns and of the analogies exhibited between the flower of the Cycadeoideae and those of the angiosperms. The strong evidence that the Cycadales are descended more or less directly from marattiaceous ancestors is summarized, and after pointing out the numerous points of resemblance the author says: "Plainly the preceding résumé of the principal characters of the two great cycad groups as combined and showing their descent from marattiaceous ferns of the Paleozoic is not merely conclusive, but one of the great cornerstones upon which the plan of evolution can rest secure."

It is evident that having to deal with such an enormously complicated plexus of forms as the ferns and pteridosperms of the Paleozoic, it is well nigh impossible to come to a definite conclusion as to the question of the common origin of the cycads proper and Cycadeoideae and the question of the possible relation of these on the one hand to the other gymnosperms, and on the other to the angiosperms. "It is believed in the Cycadeoideae and especially in the persistence in such highly organized plants of the marattiaceous synangium that we get the first unmistakable hint of the nature of angiosperm evolution and the further view would seem to be justified that while the staminate disc surrounding the ovulate axis of Cycadeoidea indicates primarily an evolution terminating, so far as now possible to trace, in the gymnosperms, the juxtaposition of parts is exceedingly suggestive of the possibility, if not the manner as well, of angiosperm development directly from filicinean forms."

The discovery that many of the supposed Marattiaceae of the Paleozoic are really seed-bearing plants, Pteridosperms, emphasizes the importance of the Marattiaceae as the ancestors of the higher seed-bearing types. Whether or not we may agree with all of the author's conclusions, this magnificent memoir must remain an indispensable source of information for every student interested in the fascinating problems of the origin of the higher plants.

The development of the ovule and female gametophyte in Ginkgo are treated in a recent paper by Miss I. E. Carothers (The Development of the Ovule and Female Gametophyte in Ginkgo. *Bot. Gaz.*, 43, pp. 16–130, Feb. 1907). The most important point brought out in the course of this study is the fact that a large amount of chlorophyll is developed in the tissues of the gametophyte. This seems to be the only instance known where the endosperm develops chlorophyll, except in the case of Cycas, where it has been found that under certain conditions the prothallium may grow out of the ovule and on exposure to the light may turn green. The paper is accompanied by two plates.

Among the most important of the recent papers on the development of the Coniferae may be mentioned two by Lawson (Gametophytes, Fertilization and Embryo of Cephalotaxus Drupacea. A. A. Lawson. *Annals of Botany*, XXI, 1907. The Gametophytes and Embryo of the Cupressineæ with Special Reference to Libocedrus decurrens. Ibid., XXI, Apl. 1907).

The first of these papers deals with *Cephalotaxus drupacea*. In this species the macrospore remains undivided until a very short time before it is shed, when it divides into two cells, the tube cell and the generative cell. No vestigial prothallial cells are present. After the separation of the stalk nucleus from the antheridial cell the latter has its nucleus divided into two equal sperm nuclei, but there is no division wall formed between them. Both sperm nuclei enter the archegonium. Probably only one megaspore develops a prothallium. The membrane is almost wanting and in this respect as well as in some others the Taxaceae are regarded as less primitive than the other conifers. The development of the prothallial tissue follows the usual course found in the Coniferae. The archegonia, which are usually four in number, offer no marked peculiarities. There are two or three neck cells, and Lawson failed to confirm the statement of Arnoldi that the nuclei of the jacket cells pass into the egg cell, and he does not think that the "proteid vacuoles" of the egg have any connection with the nuclei of the jacket cells. A ventral canal cell nucleus is always found.

Of the two sperm nuclei that enter the egg only one is functional. After fertilization the fusion nucleus divides until eight free nuclei are formed. The next divisions are accompanied by cell walls. Only one embryo is normally formed from each archegonium. The embryo shows a more or less clear division into four tiers, of which the lowermost forms a cap over the apex of the embryo proper. Very long suspensor cells develop from the tier above the embryo proper and these push the embryo into the endosperm. Secondary suspensor cells are later developed from the upper part of the embryo itself.

The author's conclusions as to the systematic position of Cephalotaxus are as follows: "From this account of the gametophytes it becomes obvious that Cephalotaxus cannot be regarded as a primitive type of the Coniferae, although this is contrary to the results obtained from certain studies on the sporophytes. . . . . Worsdell regards Cephalotaxus as the most ancient of the coniferous genera and concludes that this genus forms in a measure the connecting link between the Cycadaceae and Coniferae. . . . . By comparing the gametophytes of Cephalotaxus with the Cycadales and with the Coniferales, I cannot accept Worsdell's view. In fact I am forced to the conclusion that this genus represents a very recent type of conifer."

In the study of the Cupressineae, Dr. Lawson has taken as the principal form for study the incense cedar, *Libocedrus decurrens*, of the Pacific Coast, one of the noblest members of the family. The material was collected from the fine collection of conifers growing upon the grounds of Stanford University.

Pollination occurs in *Libocedrus decurrens* as grown at Stanford late in March or early in April. Like the other Cupressineae the pollen spores are small and each contains two cells, the smaller one being the generative cell, which afterward divides into a stalk and body cell. The latter produces two similar male cells and this seems to be the rule in the Cupressineae. No sterile prothallial cells such as occur in the Abietineae and Cycas have been found in any Cupressineae. The other genera, in which a similar division was observed. were Cupressus, Chamaecyparis, Thuja, Cryptomeria and Taxodium. Both of the latter, according to Lawson, show close affinity with the Cupressineae, with which, however, they are not usually associated. Libocedrus, in the history of the male gametophyte, approaches most nearly to Thuja.

Two megaspore mother cells are usually present and from each of these four megaspores arise. Only one of the latter, however, develops a prothallium, the others being apparently destroyed by its further growth. The megaspore in its earlier stages of growth contains several vacuoles which ultimately fuse into a single large central one surrounded by a parietal layer of cytoplasm. In the latter are many free nuclei as in other conifers. The development of the cellular tissue from the multinucleate protoplasmic layer seems to closely resemble what has been described in various other conifers and seems to offer no marked peculiarities.

The archegonia in Libocedrus as in Thuja and Juniperus are in a compact group and number from ten to fifteen. There are five or six neck cells and as in other Cupressineae and in Cephalotaxus, the ventral canal cell is represented only by the nucleus, there being no proper ventral canal cell. The whole group of archegonia is surrounded by a layer of jacket cells, but no direct protoplasmic connection could be shown between the latter and the egg cell and it is considered probable that the transfer of food substance takes place through the cell walls.

The actual fertilization was observed in both Thuja and Chamaecyparis and in both cases it was shown that the male nucleus escapes from the cytoplasmic envelope of the male cell, and coming into contact with the egg nucleus, presses into it at one side. Finally the fusion is complete. The fusion nucleus divides until eight free nuclei result, a condition that seems to be universal in the Cupressineae. The organization of the suspensor and embryo proper agrees closely in all forms studied.

Lawson considers the Cupressineae as less primitive than the Abietineae, but more so than Cephalotaxus. Three excellent plates complete the paper.

The Araucariaceae have naturally received less attention than the more accessible northern coniferous types and there is much need of a critical study of this important family. The important memoir of Professor Seward (The Araucarieae, Recent and Fossil. A. C. Seward, F. R. S. and Sibille O. Ford. *Phil. Trans. Royal Soc.*, series B, vol. 198, pp. 305–411, 1906) is therefore especially welcome.

The Araucariaceae are with few exceptions confined to the southern hemisphere, and although cultivated to a limited extent in the milder portions of Europe and in California they are not readily accessible to most of the students of the conifers and doubtless this largely is responsible for our imperfect knowledge of the more important points in their development.

The genus Agathis (Dammara) is confined to tropical and subtropical regions of Indo-Malaysia and Australasia. The Philippine Islands mark the northern limit of the genus. In the northern island of New Zealand, the home of the famous Kauri pine (*Agathis australis*) the latter species is said to extend to 38° S. Except for *A. robusta* of Queensland and some species from the Malay peninsula, the species of Agathis are essentially island types.

Full diagnoses are given of the species, of which eight are recognized in Agathis and eleven in Araucaria. Several doubtful species are also described. A full account is given of the anatomy of the genera and there is also included an account of the seedlings of several species of Araucaria.

Araucaria is confined entirely to the southern hemisphere, but while most of the species occur in the Australasian region, no less than five belonging to New Caledonia, there are two very distinct species in South America, *A. imbricata*, in Chile and *A. braziliensis* in Brazil. As the Araucariaceae are for the most part trees of warm, moist climates, it is not surprising that growth rings are very feebly marked or may be entirely absent. It is interesting to note, however, that Seward found in the trees of *A. imbricata* grown in England, well marked annual growth rings. The strobili, both male and female, especially in Araucaria, show very gradual transitions from the foliage leaves to the sporophylls. This seems to strengthen the view that both male and female sporophylls are directly homologous with the foliage leaves and this is the view that Seward accepts.

The male flowers of Araucaria are noticeable for their relatively large size, much exceeding that of the other conifers. The number of pollen sacs is large. These sporophylls of *A. imbricata* are 1.9 centimeters in length and may have as many as nineteen sporangia. The sporophylls of the large female cones bear a single very large seed, which in Agathis is provided with a single wing. In Araucaria the scale develops a ligulate appendage and the ovule is imbedded in the tissue.

The ovule and embryo were only casually studied and not much is added to what we knew before in regard to these.

The fossil Araucariaceae are perhaps of even more interest than the living ones. While there is some doubt of the occurrence of true Araucariaceae in Paleozoic rocks, it is not unlikely that they already existed during the Paleozoic. In the Mesozoic they were abundant and widely distributed. Seward does not agree with those botanists who would regard the Abietineae as perhaps the oldest existing members of the Coniferae. Of Paleozoic fossils not improbably of Araucarian affinity, the genus Walchia shows the closest resemblance to the living forms. In the Jurassic there are fossils which seem to be beyond question true Araucariaceae. Such for example is *Araucarites phillipsii*, and Seward concludes that the Jurassic flora of the northern hemisphere was rich in Araucarian conifers. All of the fossil forms resemble Araucaria rather than Agathis, which is as yet unknown certainly to occur in a fossil state, although numerous fossils have been referred to the genus.

Professor Seward's conclusions as to the affinities of the Araucariaceae and by implication of the other conifers have been strongly opposed, but we believe that his conclusions will be found to be correct. He says: "We have endeavored to show that the Araucarian type is one of the oldest, if not the oldest, of the Coniferales. .... If we have evidence that the Araucariaceae are older than Abietineae, we may reasonably expect to find that the morphological characters of the older group are simpler and less specialized than those of the new group."

Seward also defends a view that we have long maintained, that there is strong reason to believe that the resemblances between the lycopods and conifers are real evidences of relationships, particularly emphasizing the resemblance between the Paleozoic Lepidocarpon and the Araucariaceae. While he recognizes the many differences in structural details between the lycopods and Araucariaceae, he does not believe that these are so great as to forbid the assumption of a lycopodineous origin for the Araucariaceae. We fully endorse his criticism of the extreme view taken by the majority of students of gymnosperms at the present time. He says, "We are disposed to think that the proof of the relationships between cycads and ferns has been allowed an undue influence in opinion regarding the ancestry of the conifers."

Of recent papers on the Gnetaceae, the present paper by Pearson on Welwitschia (Some Observations on Welwitschia mirabilis, Hooker H. H. W. Pearson, M. A., F. L. S. *Phil. Trans. Royal Soc. London*, Series B. Vol. 198, pp. 265–304. Plates 18–22. 1906.) is easily first in point of importance.

One of the most remarkable of known plants is *W. mirabilis*, which is an inhabitant of the desert strip along the coast of Portuguese and German West Africa. In January, 1904, Professor H. H. W. Pearson of the South African College in Cape Town made a visit to Walfisch Bay for the purpose of studying and collecting Welwitschia and the present memoir is a record of his observations. Owing to a native uprising his visit was cut short, and the amount of material collected was limited, but nevertheless a number of important facts were established, which add materially to our knowledge of this extraordinary plant.

The region where it grows is an almost absolutely rainless desert, and excepting at very long intervals the only source of water is the heavy sea fog, whose condensed moisture is sufficient to sustain life in a few plants. It appears, however, that in some seasons, often a good many years apart, heavy rains occur and the country may be inundated. Pearson concludes that it is only during these rare periods of heavy rain that the moisture is sufficient to germinate the seeds of Welwitschia, although these are produced freely each season. The plant does not appear to be able to exist outside the fog belt, but Pearson believes that the main source of water supply is deep seated, as is indicated by the very deep tap root of the plant.

The plants are dioecious, the flowering male plants being more conspicuous than the female. Pearson believes that Hooker's statement that pollination takes place while the ovules are still very small is incorrect and that Strasburger was right in stating that pollination does not occur until the integument of the ovule projects above the subtending bract. There is, however, strong evidence that the plant is entomophilous, as the sticky pollen is not adapted to removal by the wind and the flowers are constantly visited by insects. After pollination, fertilization and maturing of the seed seem to go on more rapidly than in any other gymnosperms. On January 13th Pearson found very few pollinated ovules, but he was informed that a month more would be sufficient for the ripening of the seeds. While this statement needs confirmation, it may very well be true, and if so, it is probably an adaptation connected with the desert habit of the plant.

The anther develops three loculi. In addition to the true tapetal cells there is a breaking down of some of the sporogenous cells — a condition of things not at all uncommon in the sporangia of certain pteridophytes. In general there is pretty close agreement between Ephedra and Welwitschia in the structure of the stamens. The pollen spores possess three nuclei, one of which usually is completely disorganized before the spores are shed. Of these three, this disorganized nucleus presumably represents a sterile prothallial cell, while the others are respectively tube nucleus and generative nucleus. Pearson found a single archesporial cell in the megasporangium. Although some of the stages were wanting, it was concluded that the archesporial cell divides into several cells, of which one becomes the megaspore. While numbers of young embryo sacs with free nuclei were observed, no dividing nuclei were seen. No vacuole was found in the young embryo sac, a condition, by the way, which is quite similar to what obtains in Peperomia.

The upper part of the nucellus becomes more or less disorganized, and as the prothallium grows there is the usual development of cell walls between the free nuclei; but these cells later become multinucleate, presumably by the division of the original nucleus. In the lower part of the sac there may be as many as twelve nuclei, in some of these cells. The number is less in those in the upper portion of the embryo sac. The upper prothallial cells grow out into tubes penetrating the nucellar cap in much the same way that the pollen tube would do. There are several nuclei in each tube, and these are all assumed to be potentially egg cells, but this has not been definitely proven. These tubes are not to be looked upon as archegonia, but each nucleus is considered to be an egg cell as in *Gnetumgnemon* and the peculiar tube is a special adaptation which is perhaps homologous with the whole apex of the prothallium of Gnetum, with which genus Pearson seems inclined to connect Welwitschia, although of course the relationship is rather a remote one. It is understood that Professor Pearson has been engaged in further studies on this most interesting plant and the result of these studies will be looked forward to with much interest by all students of the gymnosperms.

Douglas Houghton Campbell.

Xerophily of the Gymnosperms.— Although the foliage of the conifers apparently presents adaptations to conditions of drought, Stopes (New Phytologist, 6:46–50. 1907) finds that at the present time the conifers occupy territory in which the rainfall is, in the main, plentiful. The generally accepted explanation of the occurrence of